

# **BICYCLE CARRIER**

## Cross Reference to Related Application

This application is a continuation of U.S. Patent Application Serial No. 10/196,330 filed July 15, 2002 which application is a divisional application of U.S. Patent Application Serial No. 09/910,649 filed July 20, 2001 titled "Bicycle Carrier" which application is a divisional application of U.S. Patent Application Serial No. 09/447,908 filed November 23, 1999 titled "Bicycle Carrier" and are hereby incorporated by reference.

## Field of the Invention

The present invention relates to bicycle carriers and more particularly to a fork block and wheel tray used to secure a bicycle on a roof rack.

## Background of the Invention

With the growing popularity of bicycling as a recreational activity, vehicles are often equipped with racks to transport bicycles. Such racks come in many different styles and configurations. One common configuration is a roof rack in which one or more bicycles are mounted to a pair of crossbars that extend across the top of the vehicle.

Various systems have been developed to secure and stabilize bicycles on vehicle-mounted cross arms. One such system utilizes a fork block mounted to one of the bars with a skewer extending therethrough to receive and grip the front forks of a bicycle. Typically, a wheel tray extends from the fork block to the other crossbar to receive the rear tire of the bicycle. In a slight variation, a short wheel tray is attached to only one crossbar to receive the rear wheel. One limitation of this variation is that the rear wheel

must be substantially centered over the crossbar to avoid creating excess torque on the short wheel tray and/or crossbar. This limitation can be a problem where the crossbars cannot be positioned on the vehicle to accommodate the wheel base of a particular bicycle, or where it is desirable to carry bicycles with different wheel bases.

5 In addition to meeting the basic physical requirements of mounting a bicycle on a vehicle, it is also important for a rack to permit the bicycle to be locked on to prevent unauthorized removal. In systems utilizing fork blocks, this is usually accomplished by providing a lock associated with the skewer to prevent the skewer from being opened. Existing lock designs are either unnecessarily complex or not sufficiently secure.

#### 10 Brief Description of the Figures

Fig. 1 is a perspective view of a bicycle roof rack according to the present invention.

Fig. 2 is an exploded perspective view of a fork block according to the present invention.

15 Fig. 3 is a sectional view through the fork block of Fig. 2.

Fig. 4 is a perspective view of a lower surface of a cap forming part of the fork block of Fig. 2.

Fig. 5 is a sectional view through the fork block of Fig. 2.

Fig. 6 is a cam follower forming part of the fork block of Fig. 2.

20 Fig. 7 is a view of a lock portion of the fork block of Fig. 2.

Fig. 8 is a graph of displacement as a function of rotation for various cam profiles.

Fig. 9 is an exploded perspective view of a wheel mount according to the present invention.

Fig. 10 is a sectional view of the wheel mount of Fig. 9.

Fig. 11 is a perspective view of a clip according to the present invention.

5 Figs. 12 and 13 illustrate various mounting positions for the wheel mount of Fig. 9 on a round crossbar.

Figs. 14 and 15 illustrate various mounting positions for the wheel mount of Fig. 9 on a rectangular crossbar.

10 Fig. 16 is a perspective view of an alternative wheel mount according to the present invention.

Fig. 17 is a side-sectional view of the wheel mount of Fig. 16.

#### Detailed Description of the Preferred Embodiment

A bicycle mounting system according to the present invention is shown generally at 10 in Fig. 1. System 10 includes a roof-mounted rack 12 that attaches to factory installed tracks 14 on a roof 16 of a vehicle 18. Rack 12 includes towers 20 that  
15 interconnect the tracks to crossbars 22. A bicycle 24 is secured to the crossbars by a fork block 26 and a wheel mount 28.

The construction of fork block 26 is shown in Figs. 2-7. As shown in Fig. 2, fork block 26 includes a molded plastic body 30 with an upper section 32 and a lower section  
20 34. The facing perimeters of each section are formed with stepped edges 36 that interlock with each other. The two sections are secured together by three bolts 38 that engage three corresponding nuts 40. The bolts pass through holes 42 molded in each section. A socket

44 is formed at the bottom of each hole on the lower section to receive a nut. See Fig. 3. The inside end of the socket is hexagonally shaped in cross-section to prevent the nut from rotating once placed in the socket.

Each section includes a channel 48 adapted to fit over a crossbar. The channel is shaped, as shown in Fig. 3, to allow installation on either round or rectangular bars, which are the two most common shapes. The channels are sized so that as the sections just come together, the channels grip the bar with sufficient pressure to prevent slippage along the length of the bar. A plurality of reinforcing ribs 50 run across the channels and are provided with teeth 52. The teeth bite into a pliable coating that is typically applied to the surface of round crossbars to stabilize the fork block against rotation about the bars. The teeth are generally unnecessary in the case of rectangular crossbars where the non-symmetric cross-section prevents rotation.

The upper section includes wheel tray receiver in the form of a protrusion 58 configured to receive the front end of an elongate wheel tray 60. A corresponding recess 62 is formed in the lower section. The wheel tray is secured to the protrusion by a screw that fits down through a hole 64 in the protrusion, through a hole 66 in the tray and into a flat nut 68 which rides in a track 70 formed in the bottom of the wheel tray. As will be described below, and as depicted in Fig. 1, the fork block can also be used with a short wheel tray rather than tray 60.

A ridge 74 runs across the top of the upper section with a bore 76 formed therethrough to receive a skewer 78. The ridge is formed with a gap 80 at the center and extensions 82 at each end. Metal bearing sleeves 84 are pressed over the extensions to

provide a hard surface for the forks to press against. A security cover or cap 86 fits into a recess 88 formed in the top of the upper section. The cap includes a retainer 90 that fits into the gap in the ridge around the skewer to hold the cap on the upper section. See Fig. 4.

5           It should be noted that the cap blocks access to the heads of the bolts that secure the upper and lower sections together. As a result, the sections cannot be removed from the crossbar without removing the cap. Since the cap cannot be removed without removing the skewer, as long as the skewer cannot be removed, the fork block and bicycle carried thereon cannot be removed from the vehicle.

10           The skewer is part of a skewer assembly 94, shown in Figs. 2 and 5, that also includes a cam lever 96, a cam follower 98 and an adjustment nut 100. The skewer includes a flattened section 102 with a hole 104 near the end to receive a pivot pin 106 which pivotally connects the cam lever to the skewer. The cam lever includes a slot 108 that fits over the flattened section and allows the cam lever to rotate thereon. The pin is  
15 preferably press fit through a hole 110 formed in the sides of the cam lever on either side of the slot and through the skewer.

          The cam lever includes a handle portion 112 to allow a user to pivot the lever. As the lever pivots, a cam surface 114 that rides against the cam follower. The cam surface is shaped so that as the cam lever is pivoted, it pushes the cam follower toward the fork  
20 block. More particularly, the cam surface is shaped so that, as the lever is rotated from the open position to the closed, the cam follower is moved rapidly over the first two-thirds of rotation and then slower and with greater leverage as the closed position is

approached. The shape of this profile is depicted at 115 in Fig. 8. The adjustment nut is positioned on the skewer to adjust as necessary for different fork thickness.

The described cam surface profile provides rapid throw with low force during the first part of closing where the forks have not been contacted and high force at the end to clamp the forks. As a result, it is not necessary to loosen the nut to allow the forks to be removed, even when the forks are equipped with knobs to prevent accidental wheel loss. This is in contrast to the standard eccentric circle cams utilized on prior skewers. An eccentric circle has a throw rate as a function of rotation that starts small, reaches a maximum rate of change at 90-degrees, and decreases again until the closed position is reached. See the curve indicated at 116 in Fig 8. It can be seen that curve 115 has the same slope, and therefore clamping force as a function of rotation during the final section of operation, but has a much higher slope where no pressure is required. With an offset circular cam, the overall throw cannot be increased without increasing the slope in the clamping region and thus decreasing the available clamping leverage. By way of comparison, the skewer clamp of the present invention provides more than three-eighths of an inch of throw versus the five-sixteenths or less typically found in circular cam devices. This increased throw comes without a corresponding reduction in holding force because of the shape of the cam surface. Although the size of a circular cam can be increased to achieve a desired throw, the resultant device would have less clamping force for a given torque on the cam than the system of the present invention. This reduced force may prevent adequate grip on the bicycle forks or may make the force required to close the cam unacceptably high.

The cam follower has an elongate hollow cylindrical body 118 that fits over the skewer. The body includes a serrated end 120 disposed toward the fork block to improve the grip on the bicycle fork. See Fig. 6. A spring 122 is disposed inside the cylindrical body to bias the cam follower against the cam lever. A smooth cam bearing plate 124 is  
5 formed on the opposite end of the plate for the cam surface to slide against. The bearing plate includes a lateral extension 126 with a slot 128 formed therein. The flattened end of the skewer passes through a correspondingly-shaped hole 130 in the bearing plate to prevent the follower from rotating on the skewer.

The cam lever further includes a lock-receiving bore 132 that is configured to  
10 receive a lock cylinder 134. The lock cylinder snaps into the lock-receiving bore and includes a T-shaped catch 136 that projects out of the cam lever to selectively engage slot 128 in the cam follower. In particular, with the catch oriented parallel to the slot, the cam lever can be moved freely between the open and closed positions. The open position is depicted by the dashed lines in Fig. 5. However, if the catch is rotated 90-degrees in the  
15 slot, as shown by the dashed lines in Fig. 7, the lever can no longer be rotated to release the skewer assembly. A key 138 is inserted into the lock cylinder to rotate the catch.

As depicted in Fig. 1 and described above, the rear tire can be held to the crossbar by a long wheel tray or wheel mount 28. Wheel mount 28 is shown in detail in Figs. 9-10 and includes a wheel tray portion 140. The wheel tray portion is cupped along the  
20 elongate axis to support a standard sized wheel at two circumferentially spaced points around the perimeter of the wheel. This arrangement eliminates the problem of the wheel



tray “rocking” on a single tangent point on the surface of the wheel, as occurs with straight wheel trays.

The wheel tray portion is also cupped in the direction transverse to the elongate axis to stabilize the wheel against lateral movement. The wheel is held in the tray portion by a ratchet strap 142. Ratchet strap 142 is molded as a single piece and includes a central bridge portion 144, two toothed regions 146 and grip holes 148 at each end. The ends of the ratchet strap are inserted through receivers 150 formed on each side of the wheel tray portion. A spring-biased pawl 152 is associated with each receiver and includes a circular pad 154 to allow a user to pivot the pawl. Teeth 156 formed on the pawl allow the strap to be inserted, but prevent withdrawal unless the pawl is pivoted to disengage the teeth by pressing on the circular pad. When the ends of the strap are inserted and pulled tight, the bridge portion pushes down on the bicycle wheel to hold it against the wheel tray portion.

The wheel tray portion is held to a round crossbar by a clip 160, such as shown in Fig. 11. Clip 160 includes a recess 162 sized and shaped to closely fit over a round crossbar. A split 164 allows the ends of the clip to be spread apart to install the clip on the crossbar. The top surface 166 of the clip fits against a flat mounting surface 168 formed on the bottom of the wheel tray portion. A bolt 170 fits down through the wheel tray portion and the clip and is engaged by a T-nut 172. As the T-nut is tightened, the split is pressed together and the crossbar is firmly gripped.

As shown in Figs. 12 and 13, the wheel tray portion can be mounted to the crossbar with either the bolt in front or behind the bar. Furthermore, the mount can be rotated around the bar. The ability to rotate around the bar and position the mount slightly



in front of or behind the crossbar allows the mount to accommodate bicycles with wide range of wheel bases. The longitudinal cupping of the wheel tray portion around the perimeter of the tire reduces the tendency of the wheel tray to rock on the perimeter of the wheel. This combination of rotational flexibility and stability on the tire transfers  
5 torque created when the center of the wheel is placed significantly in front of or behind the cross-arm to the frame of the bicycle instead of causing the mount to rotate around the crossbar.

The mount can also be used with a rectangular cross-section crossbar by utilizing a rectangular clip 176, as shown in Fig. 9. Clip 176 is constructed similarly to clip 160, but  
10 includes a recess that is rectangular in cross-section rather than circular. Clip 176 includes a flat side 178 and a stepped side 180. The flat side is mounted to the wheel tray portion as previously described for the round clip and can be mounted in front of or behind the crossbar to accommodate variations in wheel base. See Figs. 14 and 15. However, because of the irregular cross-sectional profile, it is not possible to rotate the  
15 clip around the bar.

In order to provide increased range of wheel base accommodation on a rectangular bar, an angled mounting surface 182 is formed on the bottom of the wheel tray portion. The angled mounting surface inclines the wheel tray portion relative to the cross-arm. This simulates in a discrete fashion the effect of rotation in the case of a round bar. As  
20 before, the mount can be attached to the crossbar with the wheel tray facing forward or backward.

Figs. 16 and 17 depict a wheel mount 186 having a monolithic construction. Mount 186 includes a wheel tray portion 188 with a construction similar to wheel tray portion 140. The bicycle wheel is secured in the wheel tray portion by an elastic band 190 with a plurality of holes 192 that is stretched between mounting studs 194 formed on each side of the wheel tray portion. The mount is secured to the bar by a clip 196 formed integrally with the bottom of the wheel tray portion. A slot 198 is formed at one side of the clip to allow it to open up to be installed over a crossbar. A bolt 200 and T-nut 202 are used to tighten the clip on the bar. It should be noted that the cross section of the opening in the clip is sculpted to allow it to be installed on either a round bar or a rectangular bar. In addition, the sculpting allows the mount to be positioned on the rectangular bar at a number of different rotational positions.

The above-described arrangements for attaching the mount to the crossbar allows the mount to accommodate wheel base variations of plus or minus 9 inches on round bars and plus or minus 6 inches on square bars. Thus, a bicycle with a wheel base of 32 inches could be mounted together with a bicycle with a 50 inch wheel base on a rack with crossbars spaced at 41 inches. Alternatively, this arrangement allows the position of the crossbars to be adjusted over a wide range of positions when mounting a bicycle of a fixed wheel base. For instance, an average mountain bike has a wheel base of 40-42 inches and can be mounted on bars spaced from 32 to 50 inches. This flexibility allows the rack to be used on a wide range of vehicle styles. With prior systems, the mounting flexibility of the short wheel mount was not possible without using a long-style wheel tray.

While the invention has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense as numerous variations are possible. Applicants regard the subject matter of the invention to include all novel and non-obvious combinations and subcombinations of the various elements, features, functions and/or properties disclosed herein. No single feature, function, element or property of the disclosed embodiments is essential to all embodiments of the invention. The following claims define certain combinations and subcombinations which are regarded as novel and non-obvious. Other combinations and subcombinations of features, functions, elements and/or properties may be claimed through amendment of the present claims or presentation of new claims in this or a related application. Such claims, whether they are different, broader, narrower or equal in scope to the original claims, are also regarded as included within the subject matter of applicants' invention.